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PTO/SB/05 (4/98)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. 520.38794X00

First Inventor or Application Identifier Tetsuhiko HIRATA

Title See 1 in Addendum

Express Mail Label No.

PTO
09/02/00
JC875 U.S.

07/24/00

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
2. ☒ Specification [Total Pages 23]
(preferred arrangement set forth below)
 - Descriptive title of the invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the invention
 - Brief Summary of the invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 17]
4. Oath or Declaration [Total Pages]
 - a. ☐ Newly executed (original or copy)
 - b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 16 completed)
 - i. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting
inventor(s) named in the prior application,
see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

5. ☐ Microfiche Computer Program (Appendix)
6. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☐ Assignment Papers (cover sheet & document(s))
8. ☐ 37 C.F.R. § 3.73(b) Statement ☐ Power of Attorney
(when there is an assignee)
9. ☐ English Translation Document (if applicable)
10. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
11. ☐ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
13. ☐ * Small Entity Statement filed in prior application
Statement(s) ☐ Status still proper and desired
(PTO/SB/09-12)
14. ☐ Certified Copy of Priority Document(s)
(if foreign priority is claimed)
15. ☒ Other: See 2 in Addendum

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☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No. _____

Prior application information: Examiner _____ Group / Art Unit: _____

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Attachment to PTO/SB/05 (4/98) Utility Patent Application
Transmittal

1. MOBILE IP NETWORK SYSTEM AND CONNECTION SWITCHING METHOD
2. - LIST & COPIES OF PRIOR ART W/REFS

004420 004420 004420

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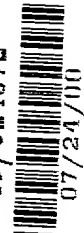
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See 37 C.F.R. §§ 1.27 and 1.28

TOTAL AMOUNT OF PAYMENT (\$)**690.00**

Complete if Known

Application Number
Filing Date **July 24, 2000**
First Named Inventor **Tetsuhiko HIRATA**
Examiner Name
Group / Art Unit
Attorney Docket No. **520.38794X00**

U.S. PTO
09/624072



METHOD OF PAYMENT (check one)

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
101 690	201 345	Utility filing fee	690.00
106 310	206 155	Design filing fee	
107 480	207 240	Plant filing fee	
108 690	208 345	Reissue filing fee	
114 150	214 75	Provisional filing fee	

SUBTOTAL (1) (\$)**690.00**

2. EXTRA CLAIM FEES

	Extra Claims	Fee from below	Fee Paid
Total Claims 12	-20** = 0	X 18	= 0
Independent Claims 1	-3** = 0	X 78	= 0
Multiple Dependent			= 0

**or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description
103 18	203 9	Claims in excess of 20
102 78	202 39	Independent claims in excess of 3
104 260	204 130	Multiple dependent claim, if not paid
109 78	209 39	** Reissue independent claims over original patent
110 18	210 9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$)**0.00**

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
105 130	205 65	Surcharge - late filing fee or oath	0.00
127 50	227 25	Surcharge - late provisional filing fee or cover sheet	0.00
139 130	139 130	Non-English specification	0.00
147 2,520	147 2,520	For filing a request for reexamination	0.00
112 920*	112 920*	Requesting publication of SIR prior to Examiner action	0.00
113 1,840*	113 1,840*	Requesting publication of SIR after Examiner action	0.00
115 110	215 55	Extension for reply within first month	0.00
116 380	216 190	Extension for reply within second month	0.00
117 870	217 435	Extension for reply within third month	0.00
118 1,360	218 680	Extension for reply within fourth month	0.00
128 1,850	228 925	Extension for reply within fifth month	0.00
119 300	219 150	Notice of Appeal	0.00
120 300	220 150	Filing a brief in support of an appeal	0.00
121 260	221 130	Request for oral hearing	0.00
138 1,510	138 1,510	Petition to institute a public use proceeding	0.00
140 110	240 55	Petition to revive - unavoidable	0.00
141 1,210	241 605	Petition to revive - unintentional	0.00
142 1,210	242 605	Utility issue fee (or reissue)	0.00
143 430	243 215	Design issue fee	0.00
144 580	244 290	Plant issue fee	0.00
122 130	122 130	Petitions to the Commissioner	0.00
123 50	123 50	Petitions related to provisional applications	0.00
126 240	126 240	Submission of Information Disclosure Stmt	0.00
581 40	581 40	Recording each patent assignment per property (times number of properties)	0.00
146 690	246 345	Filing a submission after final rejection (37 CFR § 1.129(a))	0.00
149 690	249 345	For each additional invention to be examined (37 CFR § 1.129(b))	0.00
Other fee (specify) _____			0.00
Other fee (specify) _____			0.00

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SUBMITTED BY

Name (Print/Type)	Carl I. Brundidge	Registration No. (Attorney/Agent)	29,621	Telephone	
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TITLE OF THE INVENTION

MOBILE IP NETWORK SYSTEM AND CONNECTION SWITCHING METHOD

BACKGROUND OF THE INVENTION

5 Field of the Invention

10 The present invention relates to a mobile IP network system and a connection switching method. More particularly, the invention relates to a technique of switching a logical connection for IP packet communications between a radio access network and a packet node connected to an IP (Internet Protocol) network in association with movement of a mobile station.

Description of the Related Art

15 In order to enable IP data to be transferred between a mobile station and a host connected to an IP network typified by the Internet, a network system in which a mobile communication network is connected to the IP network via a packet node having a foreign agent function in a mobile IP is being examined.

20 The mobile IP denotes a technique for enabling the communication between a mobile station and a host to be continued without changing an IP address even when the connection position between the mobile station and the IP network changes. In the mobile IP, a node having a home agent

function for each of mobile stations is preliminarily determined. The home agent function denotes a function of grasping the current position of mobile stations under the control, when an IP packet destined for a mobile station
5 under the control is received, converting the reception packet to an encapsulated packet destined for a packet node connected to a radio access network in which the mobile station is positioned at present, and transmitting the encapsulated packet to the IP network.

10 Each of packet nodes for receiving the encapsulated packet via the IP network has a foreign agent function. The foreign agent function denotes here a function of decapsulating the reception packet and transmitting the obtained IP packet to a radio access network in which a
15 destination mobile station is positioned.

By the home agent function and the foreign agent function, even when a mobile station moves between radio access networks, an IP packet can be delivered to the mobile station without changing the IP address of a transmission
20 packet.

In the following, a node having the home agent function will be called a home agent node and a node having the foreign agent function will be called a foreign agent node.

A communication between a mobile station and a host

connected to an IP network is realized by switching a logical connection between the mobile station and a foreign agent node by using a position control function peculiar to a mobile communication network and routing an IP packet
5 between the foreign agent node and the host by the mobile IP function.

The mobile IP is standardized by IETF and is described in, for example, "IP Mobility Support", C. Perkins, RFC2002, Oct. 1996. A mobile IP data communication in IMT-2000 as
10 a third-generation mobile communication network is described in "Wireless IP Network Architecture based on IETF Protocols", Tom Hiller, 1999 disclosed by TIA as a standardization organization in North America.

In the mobile IP, when a mobile station is moved from
15 a control area of a packet node (foreign agent node) to a control area of another packet node, a registration procedure for switching the foreign agent node is necessary in the home agent node.

The mobile station notifies the home agent node of a
20 destination packet node and the home agent node registers the destination packet node as a new foreign agent for the mobile station. Consequently, the home agent node can transfer an IP packet destined for the mobile station received after that to the new foreign agent (packet node

on the destination side).

The conventional technique has a problem such that it takes time from the request of the registration procedure to the response. Specifically, when a mobile station moves to a control area of another packet node and is handed over to a radio base station in the control area, until the registration is completed in the home agent node, IP packets destined for the mobile station are transferred from the home agent node to a packet node in the previous control area, so that the IP packets are not transferred to the mobile station. Although the dropped IP packets may be compensated by retransmission of the IP packets from the host in response to a request from the mobile station, when the amount of the dropped IP packets is large, a problem such that the retransmission of the IP packets severely deteriorates the throughput occurs.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a mobile IP network system and a connection switching method in which dropout of an IP packet which occurs during a registration procedure of a destination packet node is prevented.

In order to achieve the object, the present invention is characterized in that each of base station controllers in a radio access network selectively establishes a logical

connection or a logical link with a plurality of packet nodes each having a foreign agent function.

More specifically, a mobile IP network system of the invention comprises: a plurality of radio access networks each connected to a mobile station via a radio link; and an IP network to which a plurality of packet nodes for transferring an IP packet are connected, and is characterized in that a base station controller in each of the radio access networks is connected to the plurality of packet nodes, and each of the base station controllers selects one of the plurality of packet nodes in accordance with a state of each mobile station, and sets a logical connection to be used in IP packet communication of the mobile station.

In the network system according to the invention, when a mobile station is moved from a control area of another radio access network to the control area of one of the base station controllers, the base station controller can sets a logical connection for the mobile station with a previous packet node which has communicated with the mobile station in the control area of the another radio access network. That is, according to the invention, when a mobile station is moved from a radio access network to another radio access network, the IP packet communication can be continued

without performing a registration procedure for switching a foreign agent node. Thus, the problem of the dropout of IP packets in association with the registration procedure can be solved.

5 Another characteristic of a mobile IP network system according to the invention is that each of the base station controllers has means for monitoring a transmitting and receiving state of data to and from a mobile station which has moved from the control area of another radio access network, detects that data transmission and reception of the mobile station is stopped, cancels the logical connection between the base station controller and the previous packet node, and sets a new logical connection for the mobile station between the base station controller and a preliminarily designated specific packet node.

When the packet node to be connected to the base station controller via the logical connection is switched, the registration procedure by the home agent node is necessary. According to the invention, however, since the registration
20 procedure is performed during the data transmission and reception of the mobile terminal is stopped, the problem of the dropout does not occur.

The foregoing and other objects, advantages, manner of the operation and novel features of the present invention

will be understood from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram schematically showing the construction of a conventional mobile IP network system.

Fig. 2 is a diagram specifically showing a radio access network 2.

Fig. 3 is a diagram showing schematic constructions of a mobile station 1, a radio access network 2, a packet node 3, and a home agent node 5 in Fig. 1.

Fig. 4 is a diagram showing schematic constructions of base stations 6 and base station controllers 7 constructing the radio access network 2.

Fig. 5 is a diagram showing a schematic construction of a control unit 31 in the packet node 3.

Fig. 6 is a diagram for explaining the flow of communication data between the mobile station 1 and the host 4 in the conventional mobile IP network system.

Fig. 7 is a diagram showing a registration procedure sequence in the conventional mobile IP network system.

Fig. 8 is a diagram for explaining a change in a transfer route of an IP packet in the conventional mobile IP network system.

Fig. 9 is a processing sequence for changing a transfer

route of an IP packet in the conventional mobile IP network system.

Fig. 10 is a diagram showing an example of the construction of a mobile IP network system according to the invention.

Figs. 11A, 11B and 11C are diagrams showing formats of a transmission packet from a host to a mobile station, a transfer packet from a home agent node to a packet node, and a transfer packet from the packet node to a base station controller, respectively.

Fig. 12 is a diagram showing a processing sequence for changing a transfer route of an IP packet in a mobile IP network system of the invention.

Fig. 13 is a block diagram showing schematic constructions of a mobile station 1, a radio access network 2, a packet node 3 and a home agent node 5 constructing a mobile IP network system of the invention.

Fig. 14 is a diagram specifically showing the radio access network 2 in the invention.

Fig. 15 is a diagram showing the construction of a control unit 71 in a radio access network of the invention.

Fig. 16 is a diagram showing the construction of a link management table 203-3 in Fig. 15.

Fig. 17 is a flowchart showing an example of processing

operations of a logical link changing unit 203-2 in Fig. 15.

Fig. 18 is a flowchart showing another example of processing operations of the logical link changing unit 203-2 in Fig. 15.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First, for easier understanding of the present invention, a conventional mobile IP network system will be described with reference to Figs. 1 to 9.

Fig. 1 shows a general construction of the conventional mobile IP network system.

The mobile IP network system comprises: a mobile station 1; a plurality of radio access networks 2 (2A, 2B, ...); packet nodes 3 (3A, 3B, ...) each for connecting each of the radio access networks to an IP network 102; a home agent node 5 of the mobile station 1; and a host (or server) for performing communications with the mobile station. The mobile station 1 and the radio access network 2 are connected via, for example, a radio link 100 using CDMA. The radio access network 2 and the packet node 3 are connected via a dedicated line 101. The host 4 and the home agent node 5 are connected to the IP network 102, and each of the packet nodes 3 has a foreign agent function in a mobile IP.

Each of the radio access networks 2 (2A, 2B, ...) comprises, for example as shown in Fig. 2, one or more base station controllers 7 (7A, 7B, ...) connected to the packet node 3 and one or more radio base stations 6 each connected to any of the base station controllers via a dedicated line 103. The packet node 3 and the base station controllers 7 have the connecting relation of 1 to m, and the base station controller 7 and the base stations 6 have the connecting relation of 1 to n. The functions of the base station controller 7 and the base station 6 may be collected in a single device called a radio access point.

Fig. 3 shows schematic constructions of the mobile station 1, radio access network 2, packet node 3 and home agent node 5.

The mobile station 1 comprises: a man-machine interface (MMI) 12 including an external device interface function; a radio frequency unit (RF unit) 13 for communicating with the radio access network 2 through a radio channel; and a control unit 11 connected to those elements.

The radio access network 2 comprises: a radio frequency unit (RF unit) 22 for communicating with the mobile station 1 via a radio channel; a dedicated line interface (dedicated line control unit) 23 for communicating with the packet node 3; and a control unit 21 connected to those elements.

The packet node 3 comprises: one or more dedicated line interfaces 32 for communicating with the radio access network 2; an IP network interface 33 for a connection to an IP network; and a control unit 31 connected to those elements.

The home agent node 5 comprises an IP network interface 52 for a connection to the IP network and a control unit 51.

Fig. 4 shows an example of a specific construction of the radio access network 2.

The radio access network 2 comprises the one or more base station controllers 7 (7A, 7B, ...) and the plurality of base stations 6 (6A, 6B, 6C, ...) each connected to any of the base station controllers.

Each base station 6 comprises an RF unit 62 for communicating with the mobile station 1 via a radio channel; a dedicated line interface (dedicated line control unit) 63 for communicating with the base station controller 7; and a control unit 61 connected to those elements.

Each of the base station controllers 7 comprises one or more dedicated interfaces (dedicated line control units) 72 for communicating with the base station 6; a dedicated line interface (dedicated line control unit) 73 for communicating with the packet node 3; and a control unit

71 connected to those elements.

The RF unit 22 in the radio access network shown in Fig. 3 corresponds to the RF unit 62 in the base station 6, the dedicated line interface 23 corresponds to the dedicated line interface 73 in the base station control unit 7, and the control unit 21 corresponds to a combination of the control unit 61 in the base station and the control unit 71 in the base station controller.

Fig. 5 shows the construction of the control unit 31 in the packet node 3.

In the control unit 31, an OS 202 operates on hardware 201 comprising a CPU and a memory, and AP (application software) 203 which determines the behavior of a packet node operates under the control of the OS 202. Each of the control units in the mobile station 1, base station 6, base station controller 7 and home agent node 5 has basically the construction similar to that of the control unit 31.

Fig. 6 shows the flow of communication data between the mobile station 1 and the host 4 in the conventional mobile IP network system.

The host 4 generates an IP packet including transmission data to the mobile station 1 and an IP address of the mobile station 1 and transmits the IP packet to the IP network 102. The IP packet is received by the home agent

node 5 of the mobile station 1.

The home agent node 5 stores the corresponding relation between an IP address of each of mobile stations under the control and an IP address of each of packet nodes connected to the radio access network as a destination. The home agent node 5 obtains the IP address of the packet node 3A to which the reception packet is transferred on the basis of the IP address of the mobile station included in the reception packet from the host 4, adds (encapsulates) a new header in which the IP address of the packet node 3A is set as a destination address to the reception packet, and transmits the resultant to the IP network 102.

Each of the packet nodes 3 stores the corresponding relation between the IP address of each of the mobile stations connected to the radio access network under the control and an ID of a logical connection (Point to Point Protocol (PPP) connection) between the mobile station and the packet node itself. The packet node 3A removes or decapsulates the IP header from the encapsulated packet received from the home agent node 5, obtains a PPP connection ID corresponding to the mobile station on the basis of the IP address of the mobile station 1 included in the original IP packet received, adds the PPP connection ID to the original IP packet, and transmits the resultant packet to

the radio access network 2A under the control. The packet transmitted from the packet node 3A is transferred in the radio access network 2A in accordance with the PPP connection ID and is transmitted from the base station to the mobile station 1 as a destination.

The transmission data from the mobile station 1 to the host 4 is transmitted to the packet node 3A via the PPP connection between the mobile station 1 and the packet node 3A as an IP packet including the IP address of the host 4 as a destination address. The IP packet is transferred to the IP network 102 by the packet node 3A and is received by the host 4.

Fig. 7 shows a sequence of a registration procedure in the conventional mobile IP network system.

In order to realize an IP packet transfer by the above-described mobile IP, it is necessary to register in the home agent node a packet node, between which and the mobile station the logical connection (PPP connection) is established, as a foreign agent node.

When a radio link is established between the mobile station 1 and the base station 6C in the area in which the mobile station 1 is positioned by the base station controller 7B in the radio access network 2A (step 401), a request for starting packet service (transmission and reception of

packets) is sent from the base station controller 7B in the radio access network 2A to the packet node 3A (402), and a logical connection (PPP connection) is established between the packet node 3A and the mobile station 1 (403).

5 After the PPP connection is established, the packet node 3A notifies the mobile station 1 of the IP address of the packet node itself via the PPP connection (advertisement:404). The mobile station 1 which has received the advertisement requests the packet node 3A for registration (405), and the packet node 3A transfers the registration request to the home agent node 5 of the mobile station 1 (406). The home agent node 5 which has received the registration request from the mobile station 1 registers the packet node 3A as a foreign agent corresponding to the mobile station 1 and then sends a registration response to the packet node 3A (407).

20 When the packet node 3A transfers the registration response to the mobile station 1 (408), the registration procedure is completed. By the procedure, the IP packet transmitted from the host 4 to the mobile station 1 is transferred from the home agent node 5 to the packet node 3A registered as a foreign agent, so that it can be transferred to the mobile station 1 via the PPP connection established between the packet node 3A and the mobile station

1 (409).

Fig. 8 shows a change in the IP packet transfer route in the conventional IP network system in association with a movement of the mobile station.

5 For example, when the mobile station 1 moves from the radio access network 2A as a control area of the packet node 3A to the radio access network 2B as a control area of the packet node 3B, as a result of hand-over between the base stations, the radio link established between the base station 6C in the radio access network 2A and the mobile station 1 and the logical connection (PPP connection) established between the mobile station 1 and the packet node 3A are released. In stead, a radio link between the base station 6D in the radio access network 2B and the mobile station 1 and a logical connection (PPP connection) between the mobile station 1 and the packet node 3B are established.

10
15
20 A registration procedure is executed in the radio access network 2B as a destination and the packet node 3B is registered as a new foreign agent of the mobile station 1. Consequently, the IP packet transmitted from the host 4 to the mobile station 1 is transferred from the home agent node 5 to the packet node 3B and is transferred from the packet node 3B to the mobile station 1 via the PPP connection as shown by arrows with solid lines.

Fig. 9 shows a processing sequence for changing the IP packet transfer route in the conventional mobile IP network system.

When the mobile station 1 moves toward the control area
5 of the radio access network 2B while performing communication with the host via the PPP connection with the packet node 3A (409), the mobile station 1 compares the reception strength of a control signal received from the base station 6C in the radio access network 2A shown in Fig. 8 with that of a control signal received from the base station 6D in the radio access network 2B. At a time point the reception strength from the base station 6D becomes stronger, a request of handover to the base station 6D is issued (501).

The handover request is notified from the base station controller 7B in the radio access network 2A to the base station controller 7C in the radio access network 2B via a control circuit connecting these base station controllers (502). If the base station 6D can accommodate the mobile station 1, the base station controller 7C returns a handover
20 response to the base station controller 7B (503). When the base station controller 7B which has received the handover response instructs the handover to the mobile station 1 (504), the base station 6D as a destination allocates a radio channel to the mobile station 1, and a new radio link is

established between the mobile station 1 and the radio access network 2B (505).

5 The base station controller 7C in the radio access network 2B establishes the logical connection between the mobile station 1 and the packet node 3B and requests to start transmission and reception of packets to and from the mobile station 1 (506). In parallel with this, the base station controller 7B in the radio access network 2A closes the logical connection established between the mobile station 1 and the packet node 3A (507). The packet node 3B which has received the request from the base station controller 7C establishes a logical connection (PPP connection) with the mobile station (508) and notifies the IP address of the packet node to the mobile station 1 (advertisement:509).

10 In response to reception of the advertisement, the mobile station 1 requests a registration of a foreign agent to the packet node 3B (510) and the packet node 3B transfers the registration request to the home agent node 5 (511). After registering the packet node 3B as a new foreign agent
20 of the mobile station 1, the home agent node 5 transmits a registration response to the packet node 3B (512). When the registration response is transferred from the packet node 3B to the mobile station 1 (513), it is able to perform a packet communication via the PPP connection between the

mobile station 1 and the packet node 3B (514).

As described above, in the conventional mobile IP network system, when a mobile station moves to the control area of another radio access network, in association with a handover of the mobile station between the base stations, the registration procedure for switching the foreign agent is executed. In this case, during a period (T1) since the mobile station is handed over to the destination radio access network until switching of the foreign agent is completed, the home agent node 5 keeps on transferring the IP packets destined to the mobile station 1 to the previous packet node 3A. The mobile station 1 cannot therefore receive the IP packets transmitted from the host during the period T1, so that a considerable amount of IP packets are dropped out.

With reference to Figs. 10 to 18, the construction of the mobile IP network system according to the invention and the method of switching the connection will be described.

Fig. 10 shows an example of the construction of a mobile IP network system according to the invention.

The invention is characterized in that the plurality of packet nodes 3 (3A, 3B, ...) having the foreign agent function which are connected to the IP network 102 and the base station controllers 7 (7A, 7B, 7C, ...) in the radio access networks 2 are connected via a network 104 such as

an ATM network.

In the conventional mobile IP network system, the packet node 3 and the base station controllers 7 have the connecting relation of 1 to m via the dedicated lines 101, and each of the base station controllers can communicate with the IP network only via a specific packet node coupled via a dedicated line. On the contrary, in the mobile IP network system of the invention, the packet nodes 3 and the base station controllers 7 have the connecting relation of k to m ($k, m \geq 2$) via the network 104. A logical connection can be selectively established between each of the base station controllers 7 and any of the packet nodes 3.

The present invention is characterized in that, for example, when the mobile station 1 which is performing the IP packet communication via the packet node 3A moves from the radio access network 2A to the radio access network 2B and is handed over from the base station 6C to the base station 6D, the base station controller 7C in the destination establishes a logical connection with the previous packet node 3A so that the mobile station 1 can continue the IP packet communication via the packet node 3A.

In the mobile IP network system, for example, as shown in Fig. 11A, the host 4 generates an IP packet PA in which an IP header including an IP address 601 of a destination

mobile station is added to transmission data 600 destined for the mobile station 1 and transmits the IP packet PA to the home agent node 5 of the destination mobile station. A packet is transferred from the host 4 to the home agent node 5 in the form of, for example, an encapsulated packet obtained by adding the IP address of the home agent node as a destination IP address to the IP packet PA.

The home agent node 5 has a management table in which the IP address of a packet node in the radio access network in which each of the mobile stations is positioned at present is stored in correspondence with the IP address of a mobile station under the control. When a packet from the host 4 is received, the home agent node 5 refers to the management table on the basis of the IP address 601 of the destination mobile station included in the reception packet PA and retrieves the IP address of the packet node 3A to which the reception packet is transferred. The home agent node 5 adds an IP header including an IP address 602 of the packet node 3A as a destination address to the received IP packet PA and transmits the resultant as an encapsulated packet PB shown in Fig. 11B to the IP network 102.

The packet node has a management table in which the corresponding relations among the IP address of the mobile station which is performing communication via the PPP

connection, the PPP connection ID, and the IP address of the base station controller related to the PPP connection. When a packet is received from the home agent node 5, the packet node decapsulates the reception packet PB, refers to the management table on the basis of the destination mobile station IP address 601 in the obtained IP packet PA, and retrieves the corresponding PPP connection ID and the IP address of the base station controller (BSC). The packet node 3A adds a header including a PPP connection ID 603 and an IP address 604 of the base station controller 7B as a destination address to the reception IP packet PA and transmits the resultant in the form of a packet PC shown in Fig. 11C to the network 104. When the network 104 is an ATM network, the packet PC is converted to a plurality of ATM cells to each of which a cell header including an ID (VPI/VCI) of the logical connection between the packet node 3A and the base station controller 7B is added and the resultant is transmitted to the network 104.

The base station controller 7B eliminates the IP address 604 from the reception packet PC and transfers the resultant packet to the base station 6C specified by the PPP connection ID 603. The base station 6C transfers the reception packet to the mobile station 1 via a radio link specified by the PPP connection ID 603. The mobile station

1 checks the destination IP address 601 of the reception packet and performs a process of receiving the IP packet destined to itself.

Fig. 12 shows a processing sequence for changing the transfer route of the IP packet in the mobile IP network system of the invention. In Fig. 12, in order to make comparison with the conventional processing sequence described in Fig. 9 easier, the corresponding steps are designated by the same reference numerals. In the following, on the precondition that the mobile IP network system of Fig. 10 is used, description of the above sequence will be omitted here but the processing sequence for changing the IP packet transfer route in the invention will be described.

When the mobile station 1 which is PPP connected to the packet node 3A is moved to the control area of the radio access network 2B, a handover request is sent from the mobile station 1 to the base station controller 7B in the radio access network 2A (501), and a radio channel of the radio access network 2B is allocated to the mobile station 1 via handover procedures 502, 503 and 504 similar to the conventional handover procedures (505).

In the present invention, when the base station controller 7B in the radio access network 2A which has received the handover request (501) from the mobile station

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1 notifies the handover request to the base station controller 7C in the radio access network 2B, the ID of the packet node 3A to which the mobile station 1 is presently PPP connected is also notified to the base station controller 5 7C (502).

The base station 6C itself may send the handover request (501) with respect to the mobile station 1 to the base station controller 7B when the base station 6C detects that the strength of the received radio wave from the mobile station 1 which is performing communications drops below a predetermined level. It is also possible that the mobile station 1 issues a handover request to the base station controller 7C via the destination base station 6D and the base station controller 7C instructs handover to the mobile station 1. In this case, the base station controller 7C has to be notified of the ID of the base station controller 7B, which is being connected from the mobile station 1, to inquire the base station controller 7B of the ID of the packet node which is PPP connected to the mobile station 1.

20 When a radio link is established between the mobile station 1 and the destination base station 6D (505), in the conventional system, the base station controller 7C connected to the base station 6D sends a request of the packet transmission and reception to and from the mobile station

1 to the specific packet node 3B preliminarily designated (506) and a new logical connection (PPP connection) to communication with the mobile station 1 is established (508). In contrast, in the invention, the base station controller 5 7C sends the request of packet transmission and reception to and from the mobile station 1 to the previous packet node 3A to which the mobile station 1 is PPP connected at the time of handover (701). The packet node 3A changes the destination address 604 to the IP address of the base station controller 7C as a request source in a state where the PPP connection to the mobile station 1 is maintained, and transfers the IP packet destined to the mobile station 1 to the base station controller 7C. When an ATM network is used as the network 104, a preset PVC (Permanent Virtual Connection) can be used for the packet communication between the base station controller and the packet node.

In parallel with the operation of the base station controller 7C, the base station controller 7B closes the logical connection for the mobile station 1 between the base station controller 7B and the packet node 3A (702). In this case, since the connecting relation between the mobile station 1 and the packet node 3A is unchanged, the registration procedure of the foreign agent node is unnecessary and communication interruption time T2 in the

destination radio access network 2B is extremely short.

In the invention, each of the base station controllers monitors a transmitting and receiving state of the IP packet for each mobile station under control, confirms that the transmission and reception of the IP packet to and from the mobile station is ceased, and executes the registration procedure. For example, the base station controller 7C is provided with a data flow monitoring timer for repeating measurement of elapsed time each time the IP packet is transmitted and received to and from the mobile station 1. When the data flow timer times out, it is determined that the transmission and reception of the IP packet is ceased. A request of starting packet service (packet transmission and reception) is sent to a specific packet node (in this example, the packet node 3B) which is preliminarily designated for each base station controller (506) and the logical connection related to the mobile station 1 with the packet node 3A which has been performing communications is closed (704). By the operation, the logical connection (PPP connection) between the mobile station 1 and the packet node 3B is established (508) and a registration is executed by a procedure (509 to 513) similar to the conventional one.

In order to shorten the time required for the registration, for example, it is also possible that, at the

time point a handover request is received (502), the base station controller 7C requests the specific packet node 3B to set a temporary logical connection and, when the data flow monitoring timer times out, an advertisement request is issued to the mobile station 1. It is also possible to restart the data flow monitoring timer by the base station controller 7C after completion of the registration procedure and, when the timer times out again, a dormant processing (705) for releasing the radio channel allocated to the mobile station 1 may be executed in order to effectively use the radio channel.

Fig. 13 shows schematic constructions of the mobile station 1, radio access network 2, packet node 3 and home agent node 5 which construct the mobile IP network system of the invention.

The difference from the conventional system shown in Fig. 3 is that the radio access network 2 and the packet node 3 have interfaces (IP network interfaces: ATM network interfaces) 24 and 34 for connection to the common network 104 in place of the dedicated line interfaces 23 and 32.

Fig. 14 specifically shows the construction of the radio access network 2.

Each of the base station controllers 7 (7A and 7B) in the radio access network 2 has a line interface (IP network

interface: ATM network interface) 74 for connection to the common network 104 in place of the dedicated line interface 73 for communicating with the packet node 3. The common network 104 is an IP network such as an ATM network and includes IP nodes (ATM switches) 8A, 8B, 8C, ... for accommodating the plurality of base station controllers 7 and the plurality of packet nodes 3.

Fig. 15 shows an embodiment of the control unit 71 in the base station controller in each of the radio access networks.

The control unit 71 in the base station controller comprises: hardware 201 such as a CPU and a memory, a real-time OS 202, and an application 203 which operates under the control of the OS. The application has not only a radio resource management unit 203-1 but also, for each of the mobile stations under the control, a data flow monitor 203-4 for monitoring the flow of transmission and reception data, a data flow monitoring timer 203-5 for measuring time in which the data transmission and reception to and from each of the mobile stations is ceased on the basis of the result of the monitoring of the data flow monitor, a timer information table 203-6 for storing data such as a time-out value required by the data flow monitoring timer, a link management table 203-3 for memorizing a packet node which

is PPP connected at present for each mobile station under the control, and a logical connection changing unit 203-2 for controlling the switching of the logical connection (PPP connection) on the basis of the link management table.

5 The link management table 203-3 stores, for example as shown in Fig. 16, the relations among an ID 301 of a mobile station under the control of the base station controller 7, an ID 302 of a packet node to which the mobile station is PPP connected at present, and an ID 303 of a preliminarily designated specific packet node. As the ID 303 of the specific packet node, a packet node having the shortest connecting path with the base station controller 7 is registered.

10 Fig. 17 shows processes of the logical link changing unit 203-2 executed by the control unit 71 in the base station controller 7 when the data flow monitoring timer 203-5 times out.

15 When the data transmission and reception of a certain mobile station is stopped for predetermined time or longer and the data flow monitoring timer 203-5 times out, the logical link changing unit 203-2 refers to the link management table 203-3 and compares the packet node 302 in connection and the designated packet node 303, corresponding to the mobile station, thereby determining whether or not

20

the mobile station is PPP connected to the preliminarily designated specific packet node (step 801).

In the case where the mobile station is PPP connected to the preliminarily designated packet node, the routine advances to a dormant mode and the radio channel allocated to the mobile station is released (802). The data flow monitoring timer is started again and the process is terminated (804). If the mobile station is PPP connected to a packet node except for the designated packet node, a request for starting the transmission and reception of packets to and from the mobile station is issued to the designated packet node in order to PPP connect the mobile station to the designated packet node. After the ID of the designated packet node is registered in the packet node in connection field 302 (803), the data flow monitoring timer is started again and the process is terminated (804).

Fig. 18 shows the processing operation of the logical link changing unit 203-2 in the base station controller 7 in the radio access network 2 which does not have the dormant processing function.

The logical link changing unit 203-2 waits for a time-out signal from the data flow monitor 203-4 (901). When the time-out signal is received, that is, it is detected that the data transmission and reception of a certain mobile

station is ceased for predetermined time or longer, it is determined, by referring to the link management table 203-3, whether or not the mobile station is PPP connected to the specific packet node preliminarily designated in the self
5 base station controller (902).

When the mobile station is PPP connected to the designated packet node, measurement of the data flow is started again (904). When the mobile station is PPP connected to a packet node other than the designated packet node, in order to PPP connect the mobile station to the designated packet node, a request for starting the transmission and reception of a packet to and from the mobile station is sent to the designated packet node and the ID of the designated packet node is registered in the field
10 302 of the packet node in connection (903). After that, the measurement of the data flow is started again (904).
15

As obviously understood from the embodiment, the invention is characterized in that the plurality of packet nodes 3 connected to the IP network 102 and a plurality of
20 base station controllers 7 in the radio access network 2 are connected to each other via the network 104, and each of the base station controllers can selectively connect the mobile station handed over from another radio access network to any of the packet nodes.

In the embodiment shown in Fig. 10, the network 104 for connecting the packet node 3 and the base station controller to each other and the IP network 102 to which the home agent node is connected are separate networks. In order to achieve the object of the invention, however, the network 104 may be a part of the IP network 102. That is, the following manner may be also used in which each of the base station controllers 7 is connected to the IP network 102 and, for example, the packet node 3A transfers an IP packet, which is transferred from the home agent 5 to the packet node 3A via the IP network 102, to the base station controller 7B or 7C via the IP network 102.

As obviously understood from the foregoing embodiment, according to the invention, a logical connection can be selectively established between each of the base station controllers in the radio access network and an arbitrary packet node having the foreign agent function. Consequently, when a mobile station is handed over from one radio access network to another radio access network, without switching the foreign agent node in the destination radio access network, the mobile station can be logically connected to the previous packet node and the IP packet communication can be continued. The mobile IP packet communication which avoids dropout of packets during

10

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What is claimed is:

1. A mobile IP network system comprising:

a plurality of radio access networks each connected to mobile stations via radio links; and

5 an IP network to which a plurality of packet nodes for transferring IP packets are connected,

wherein each of the radio access networks has at least one base station controller and at least one radio base station which is connected to the base station controller to perform radio communications with a plurality of mobile stations, and each of the base station controllers in the radio access network is connected to the plurality of packet nodes to each other, and selects one of the plurality of packet nodes in accordance with a state of each mobile station to establish a logical connection to be used in IP packet communication of the mobile station.

2. A mobile IP network system according to claim 1, wherein each of said base station controllers selects, with respect to a mobile station moved from a control area of another radio access network to the control area of the base station controller, a previous packet node which has communicated with the mobile station in the control area of the another radio access network and to establish a logical connection for the mobile station.

3. A mobile IP network system according to claim 2,
wherein each of said base station controllers has means for
monitoring a transmitting and receiving state of data to
and from a mobile station which has moved from the control
5 area of another radio access network, thereby to cancel the
logical connection between the base station controller and
the previous packet node, and to establish a new logical
connection for the mobile station between the base station
controller and a preliminarily designated specific packet
10 node, upon detecting that data transmission and reception
of the mobile station is ceased.

4. A mobile IP network system according to claim 3,
wherein said specific packet node has means for notifying
a home agent node of the mobile station connected to the
IP network, of setting of a new logical connection for the
15 mobile station so that the home agent node having received
the notification transfers IP packets, which are destined
for the mobile station and received thereafter from the IP
network, to the specific packet node.

20 5. A mobile IP network system according to claim 1,
wherein each of the plurality of packet nodes has a foreign
agent function for transferring an IP packet received from
a home agent node connected to the IP network to any of the
base station controllers.

6. A method of switching a connection for communication between a mobile station connected to any of a plurality of radio access networks via a radio link and a plurality of packet nodes connected to an IP network, comprising:

5 a step of establishing a first logical connection to be used for an IP packet communication of a mobile station connected to a first radio access network, between the mobile station and a first packet node which is preliminarily related with the first radio access network;

10 a step of connecting the mobile station to a second radio access network adjacent to the first radio access network; and

15 a step of establishing a second logical connection between the second radio access network and the first packet node,

wherein the IP packet communication between the mobile station and the first packet node is maintained via the second logical connection.

7. A connection switching method according to claim 6,
20 further comprising a step of canceling, upon detecting that data transmission and reception in the second logical connection is ceased, the second logical connection and establishing a third logical connection to be used for an IP packet communication of the mobile station between the

second radio access network and a second packet node which is preliminarily related with the second radio access network.

8. A base station controller for a radio access network
5 for transmitting and receiving an IP packet to and from a packet node which is connected to an IP network and has a foreign agent function, comprising:

10 a first communication interface for connection to a radio base station, a second communication interface for communication with a plurality of packet nodes connected to the IP network, and a control unit connected to the first and second communication interfaces,

15 wherein the control unit selectively establishes a logical connection to be used for an IP packet communication of a mobile station connected to the radio base station via a radio channel, between the base station and any of the packet nodes via the second interface.

9. A base station controller according to claim 8, wherein
20 said control unit has means for selecting a first packet node which has been communicating with a mobile station in a control area of another radio access network, to establish a first logical connection to be used for the IP packet communication of the mobile station which has moved into a control area of the base station controller from the

another radio access network.

10. A base station controller according to claim 8, wherein said control unit has means for notifying a base station controller in another radio access network of identification
5 information of a previous packet node which has communicated with the mobile station moved from a control area of the base station controller to the another radio access network.

11. A base station controller according to claim 9, wherein said control unit comprises:

10 means for monitoring transmission data in the first logical connection; and

means for switching the first logical connection to a second logical connection which is connected to a second packet node when it is detected by the monitoring means that
15 the transmission data is stopped.

12. A base station controller according to claim 11, wherein said second communication interface is connected to a communication network for connecting the plurality of packet nodes, and said switching means cancels the first
20 logical connection and establishes a second logical connection connected to the second packet node, which is preliminarily designated to the base station controller, when said monitoring means detects the stop of transmission data.

ABSTRACT OF THE DISCLOSURE

In a mobile IP network system comprising a plurality of radio access networks 2 for connecting with mobile stations 1 via radio links and an IP network 102 connected with a plurality of packet nodes for transferring IP packets, each of the radio access networks has at least one base station controller 7 and at least one radio base station 6 connected to the base station controller. Each of the base station controllers 7 in the radio access network is connected to the plurality of packet nodes to each other via a network 104 and selects one of the plurality of packet nodes in accordance with a state of each mobile station to establish a logical connection to be used in IP packet communication of the mobile station.

FIG. 1
PRIOR ART

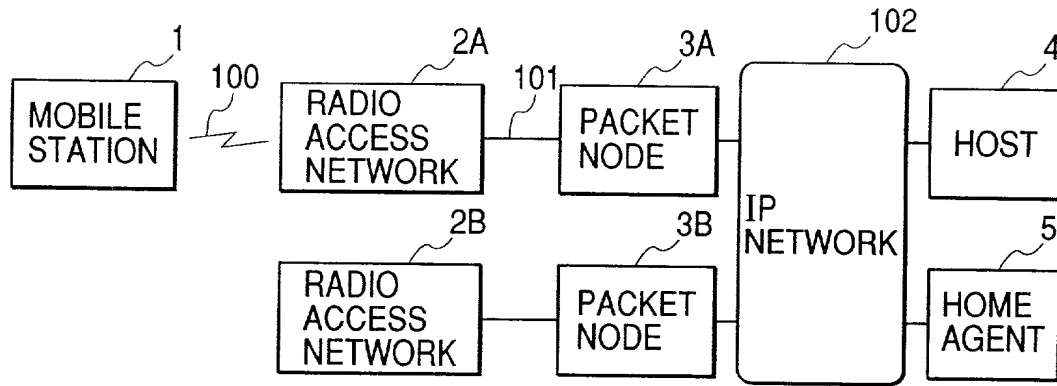


FIG. 2
PRIOR ART

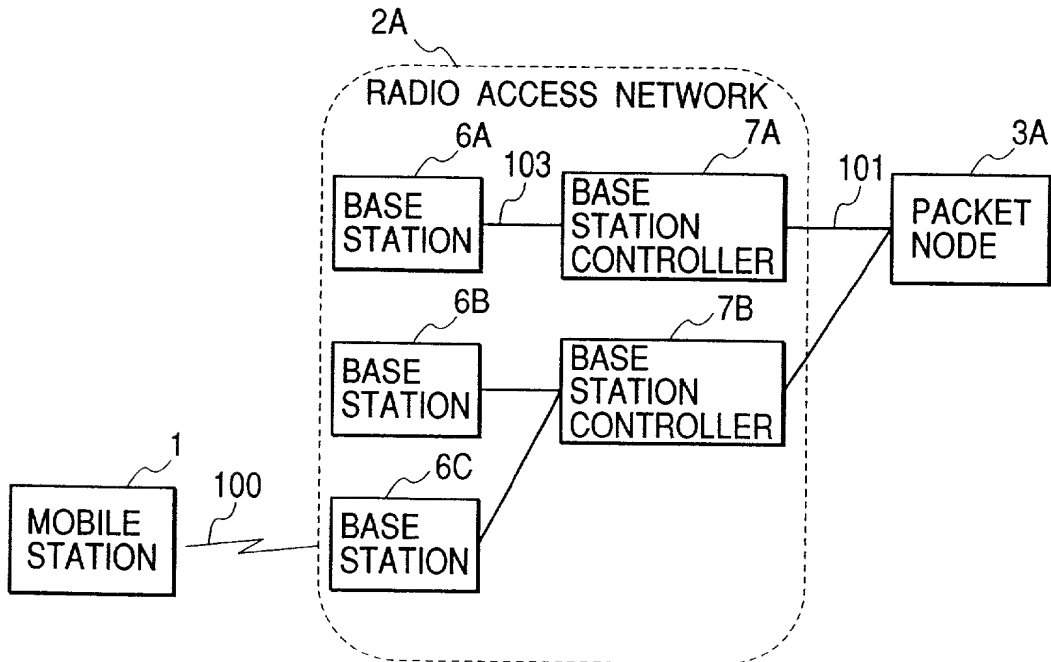


FIG. 3
PRIOR ART

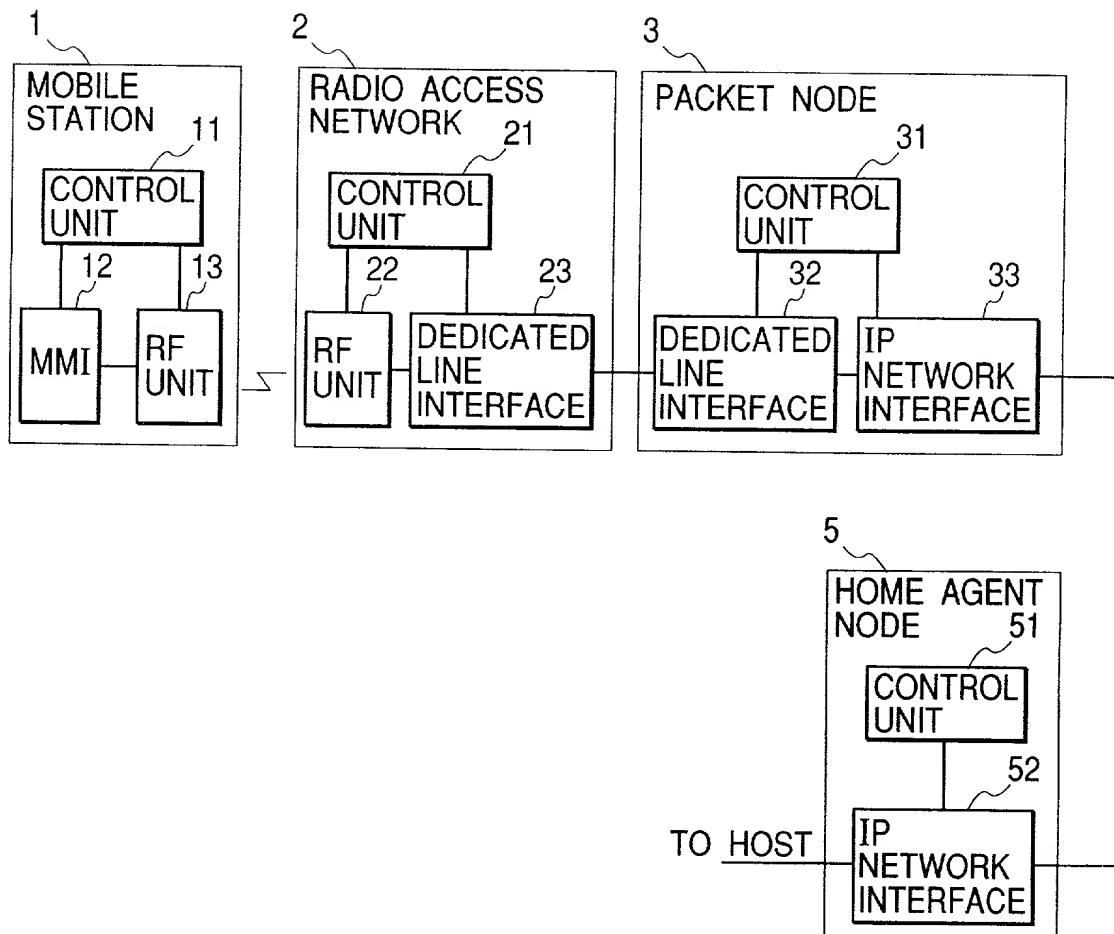


FIG. 4
PRIOR ART

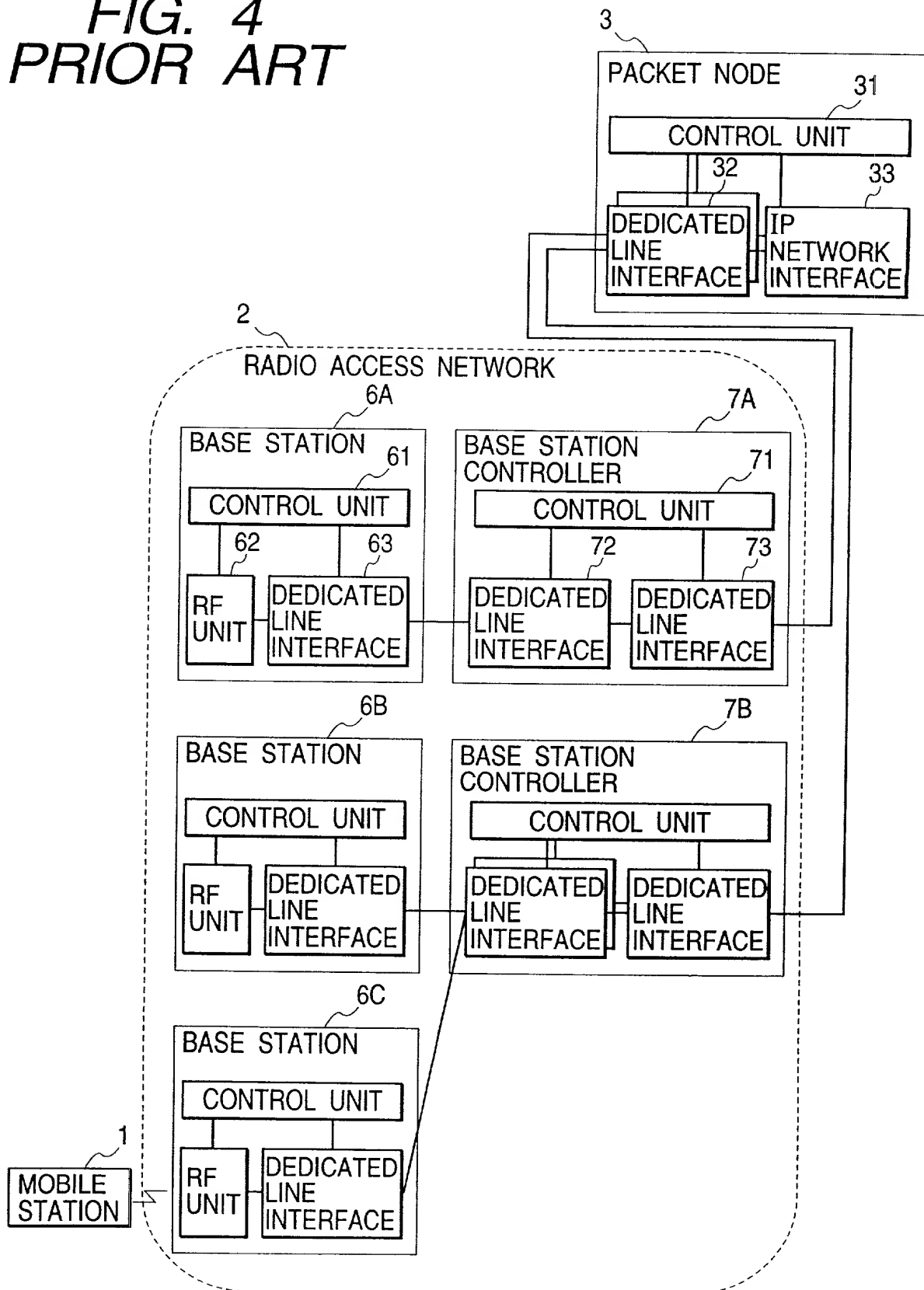


FIG. 5
PRIOR ART

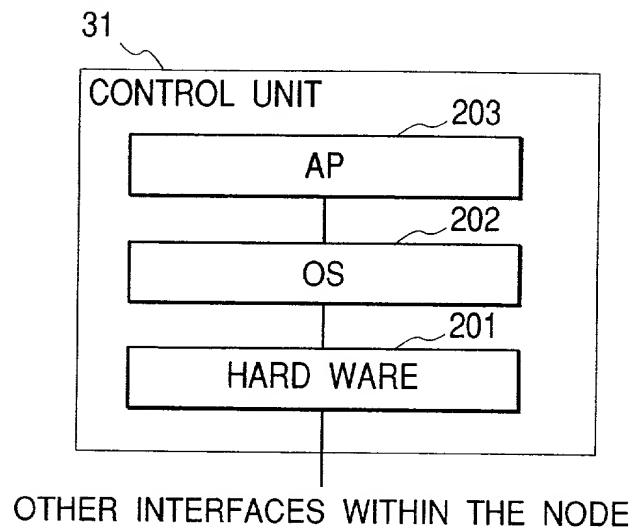


FIG. 6
PRIOR ART

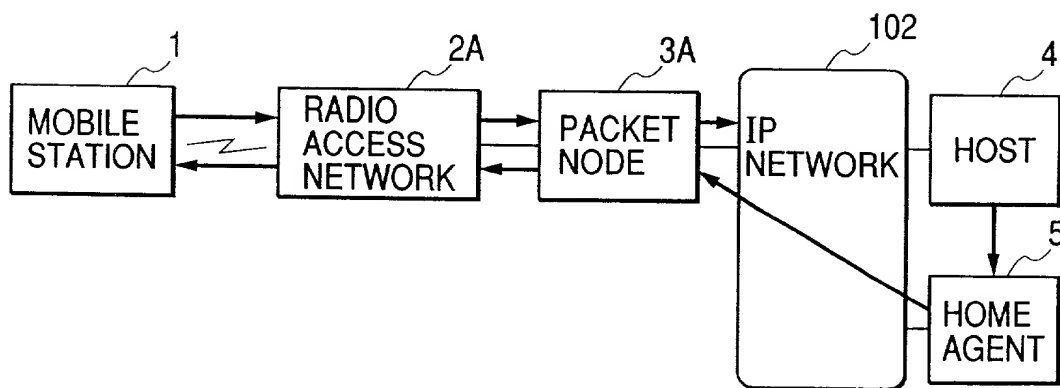


FIG. 7 PRIOR ART

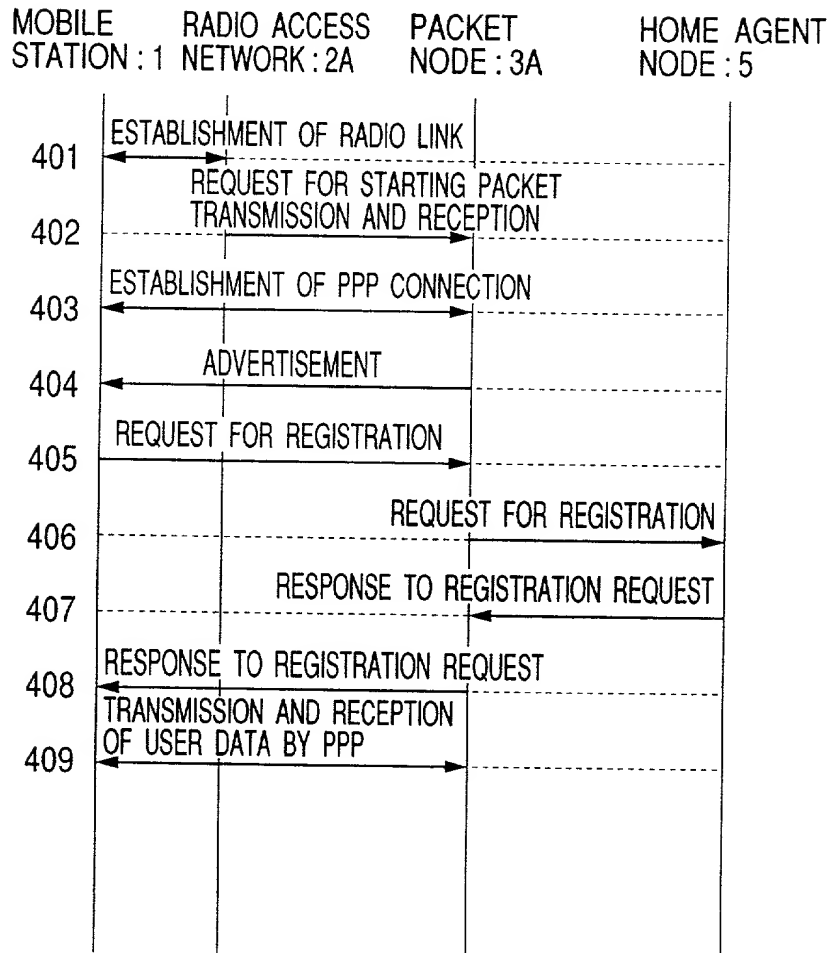


FIG. 8
PRIOR ART

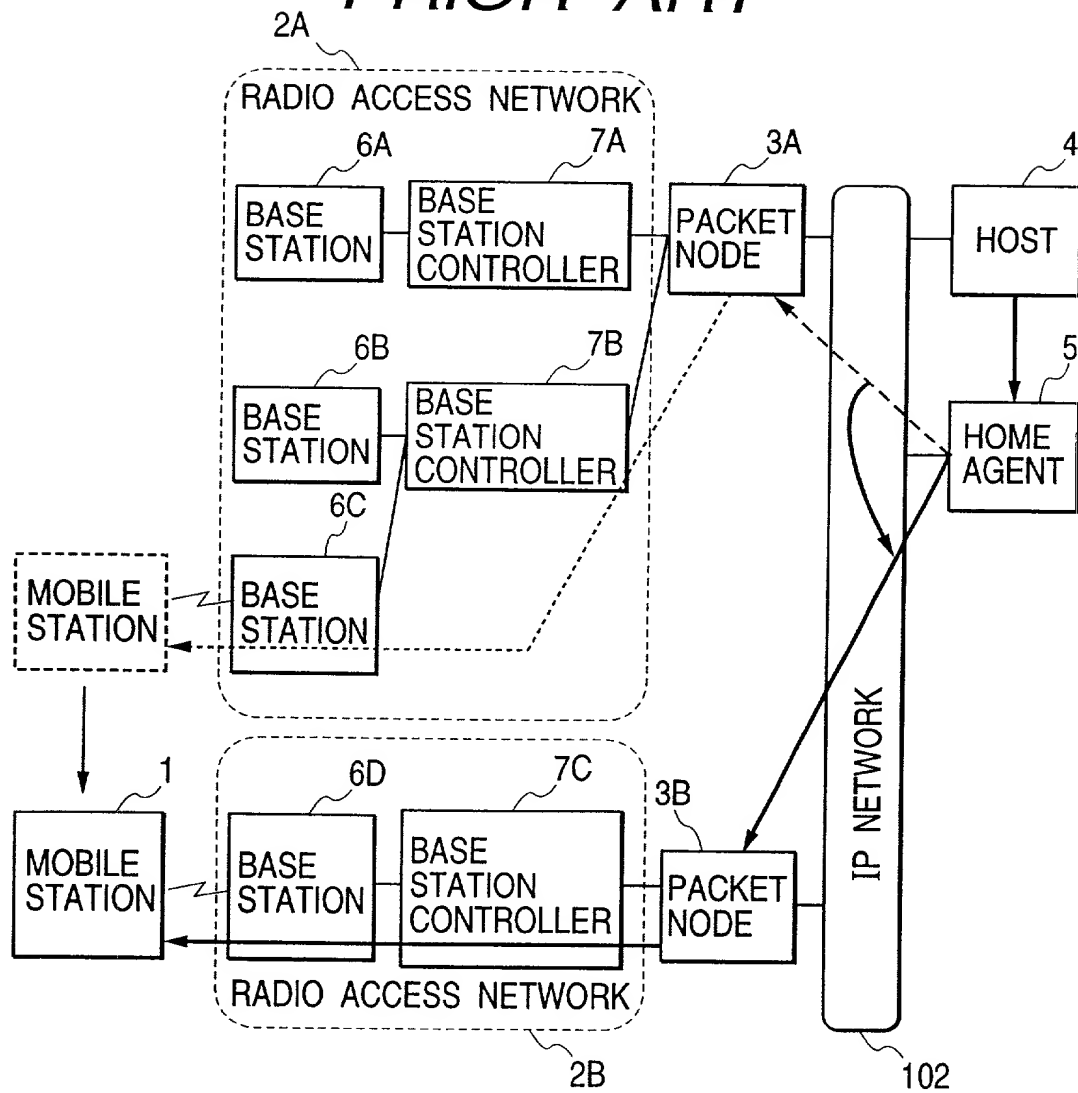


FIG. 9 PRIOR ART

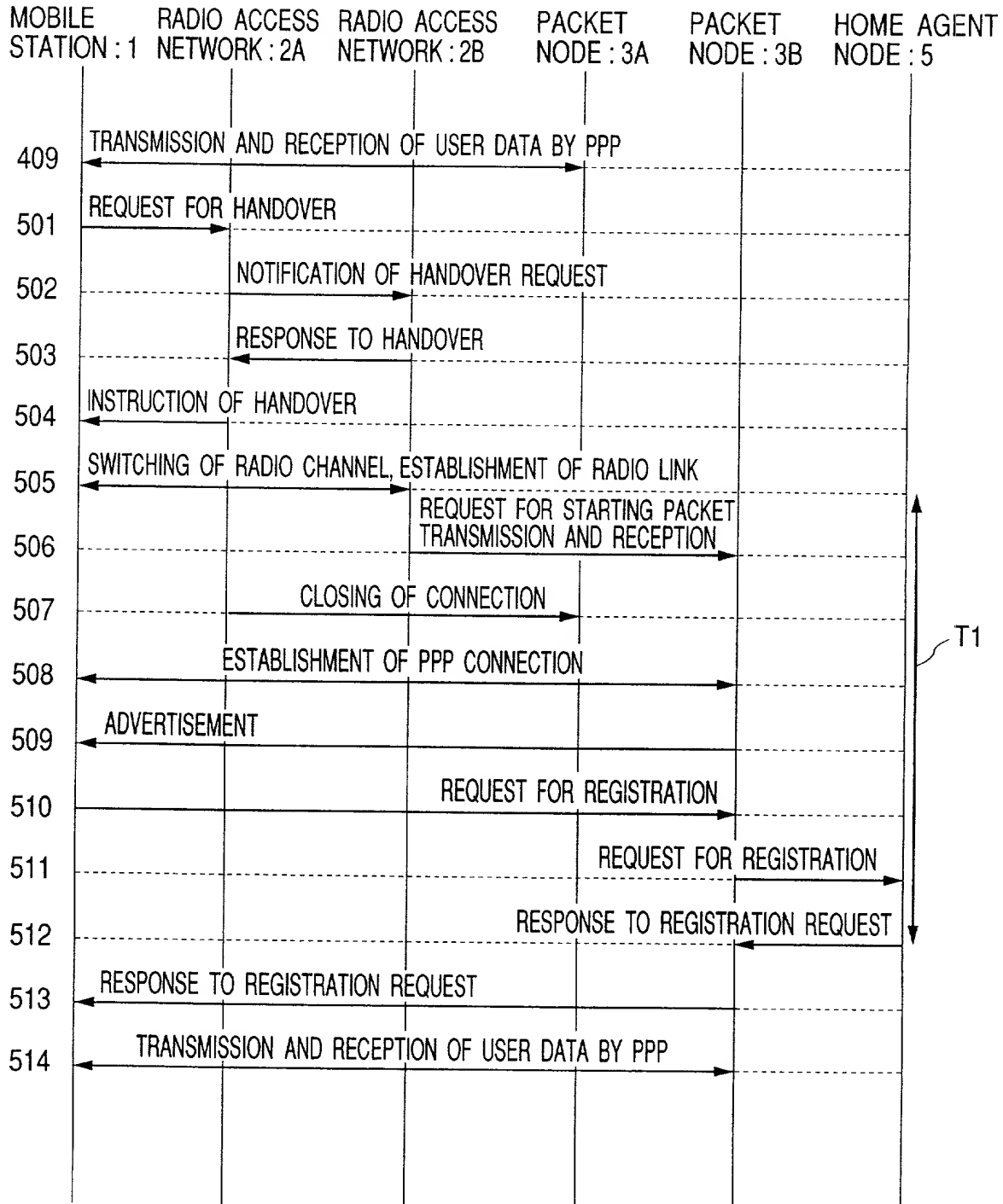


FIG. 10

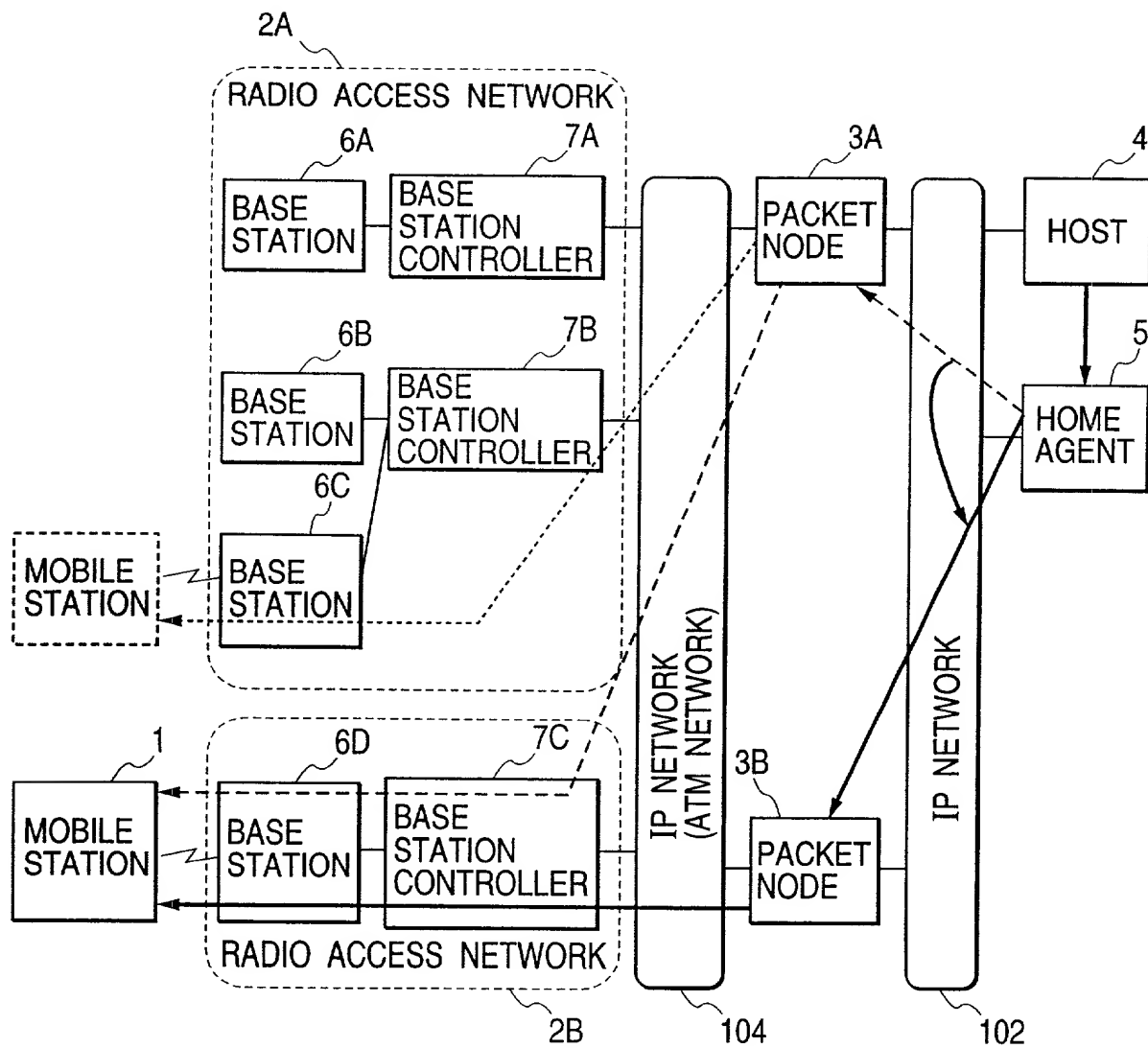


FIG. 11(A)

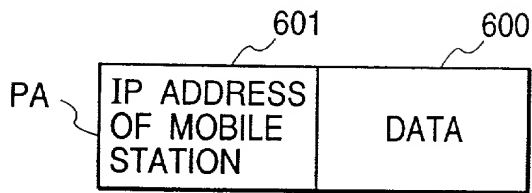


FIG. 11(B)

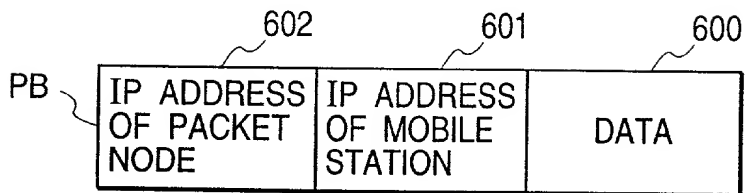


FIG. 11(C)

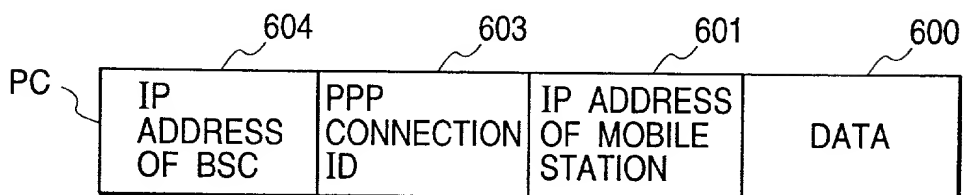


FIG. 12

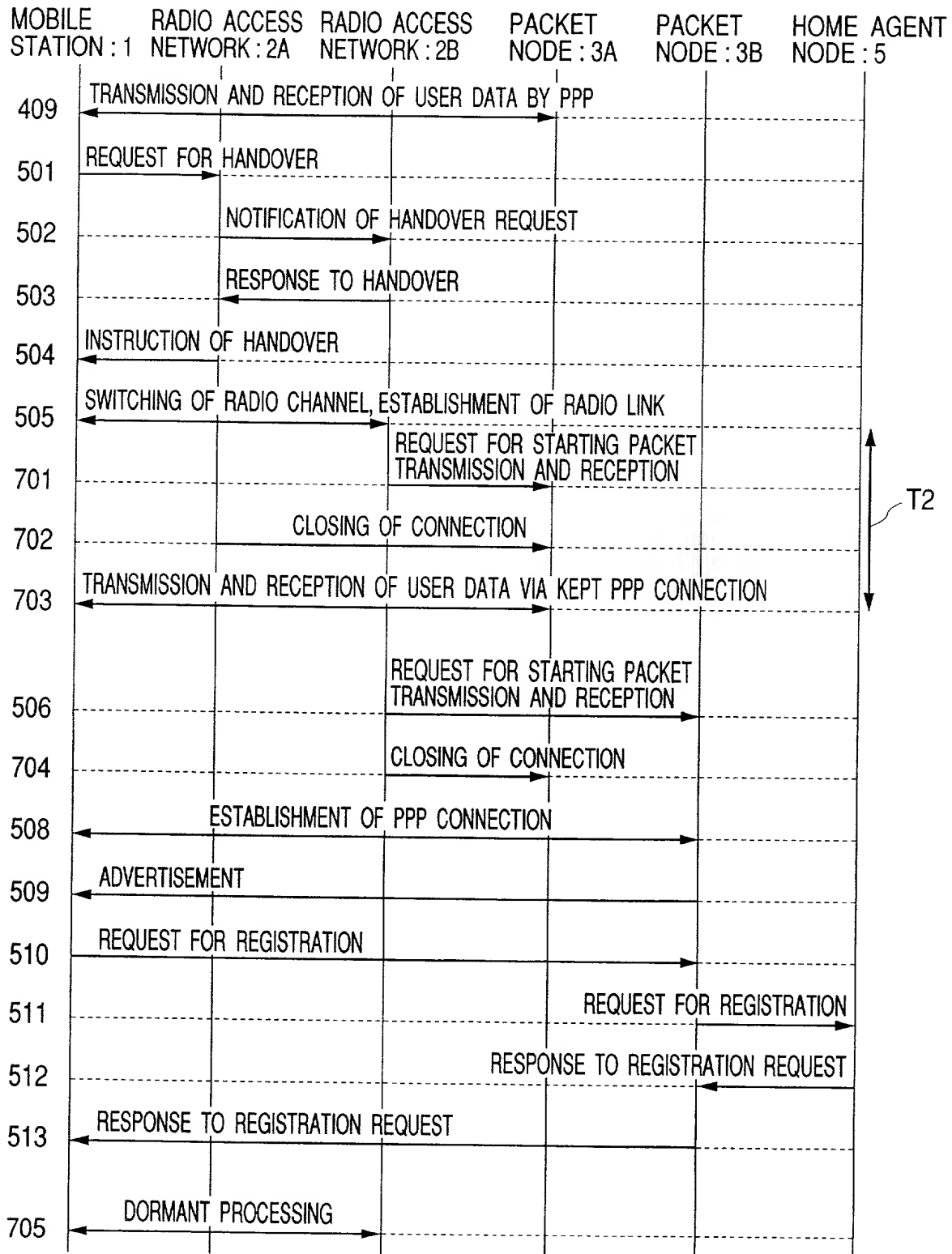


FIG. 13

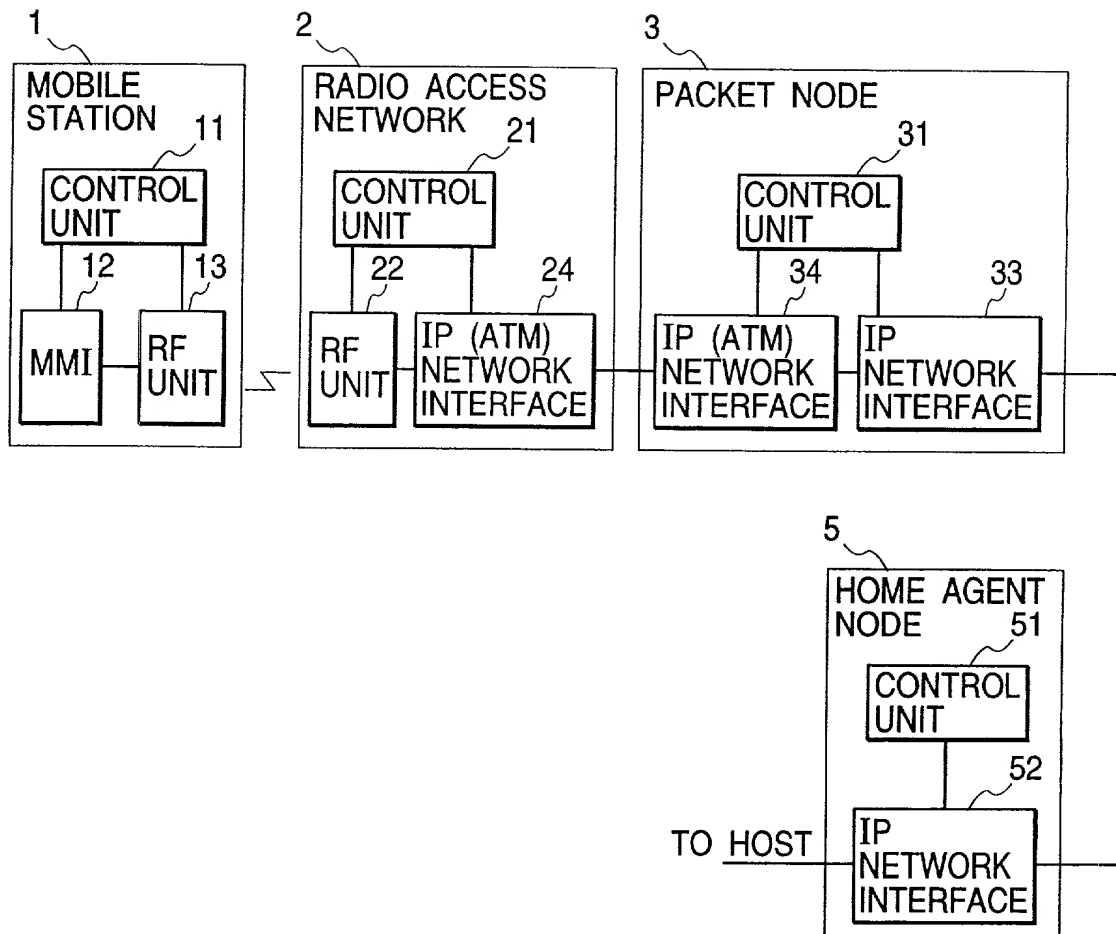


FIG. 14

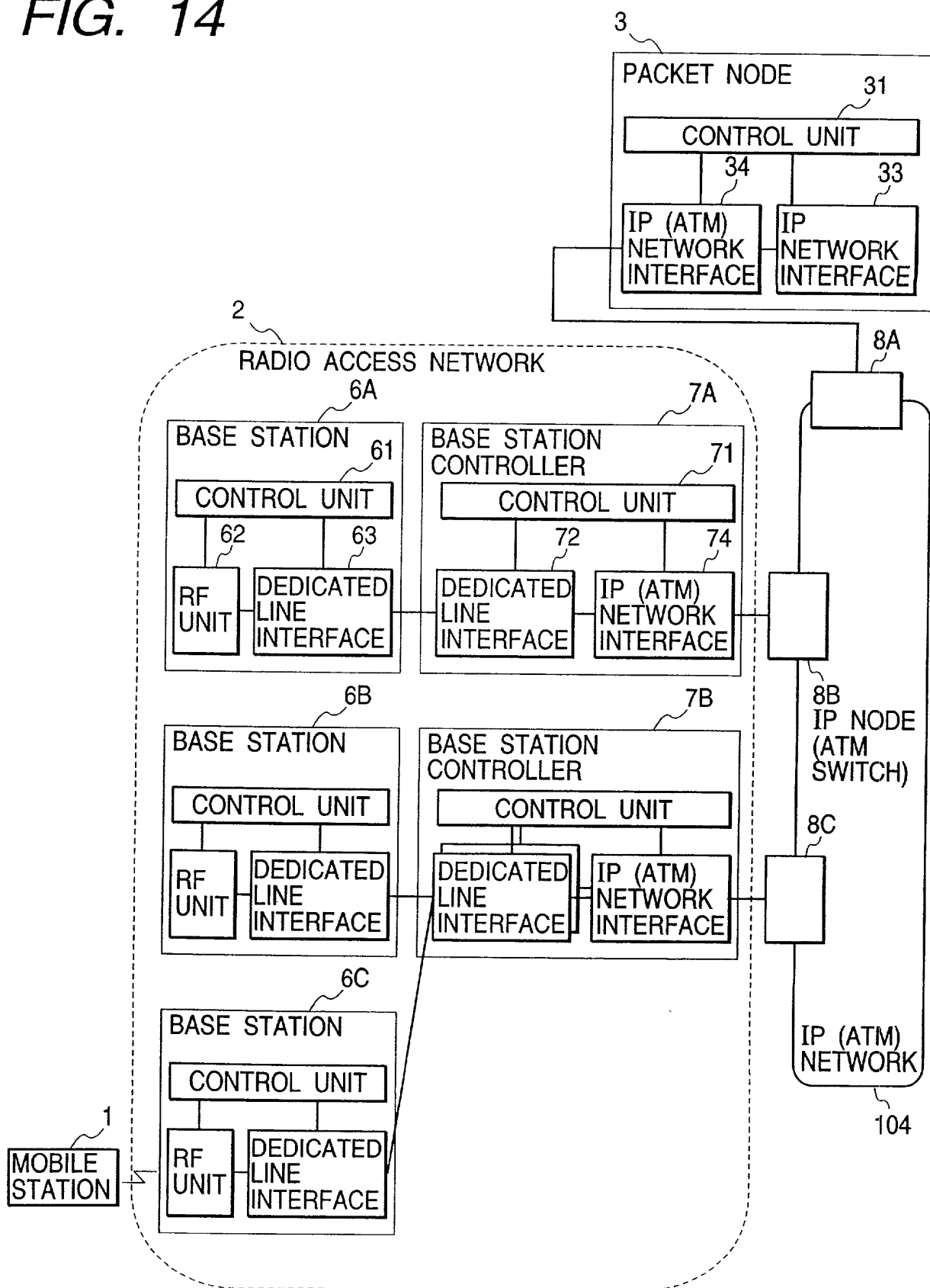
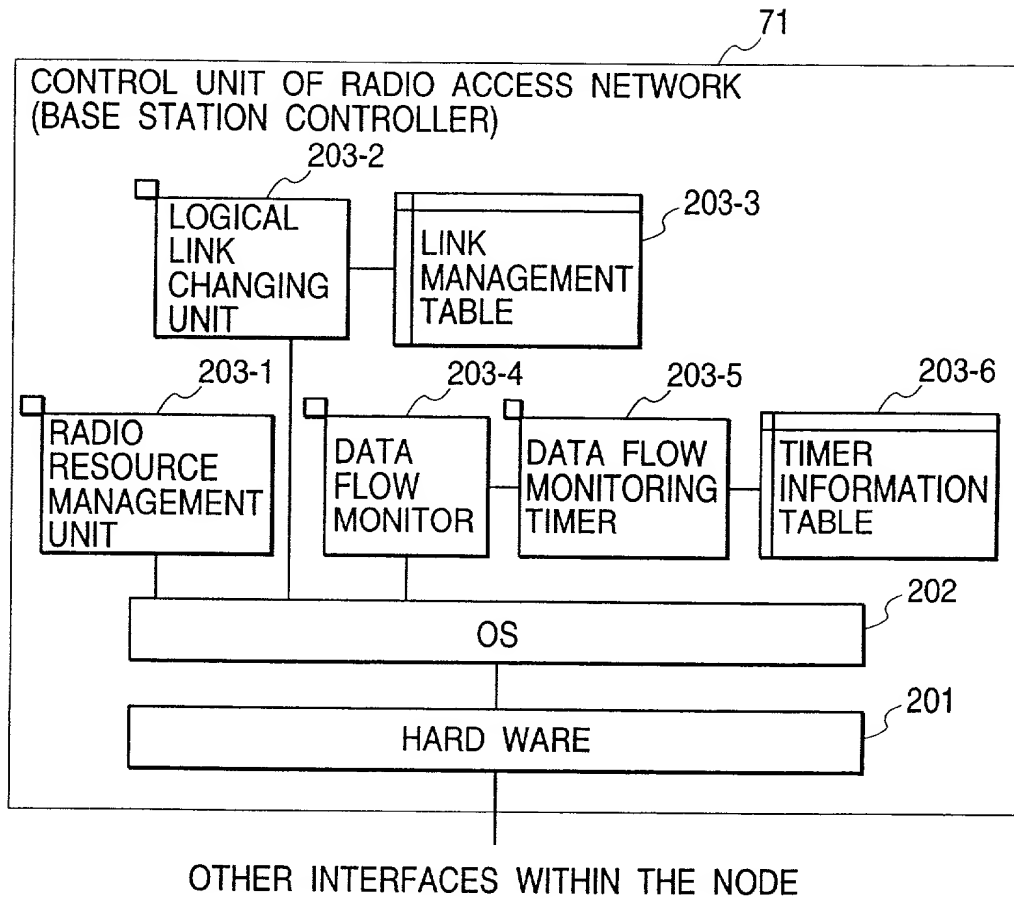


FIG. 15**FIG. 16**

LINK MANAGEMENT TABLE 203-3

MOBILE STATION ID	PACKET NODE IN CONNECTION	DESIGNATED PACKET NODE
XXX	3A	3B

FIG. 17

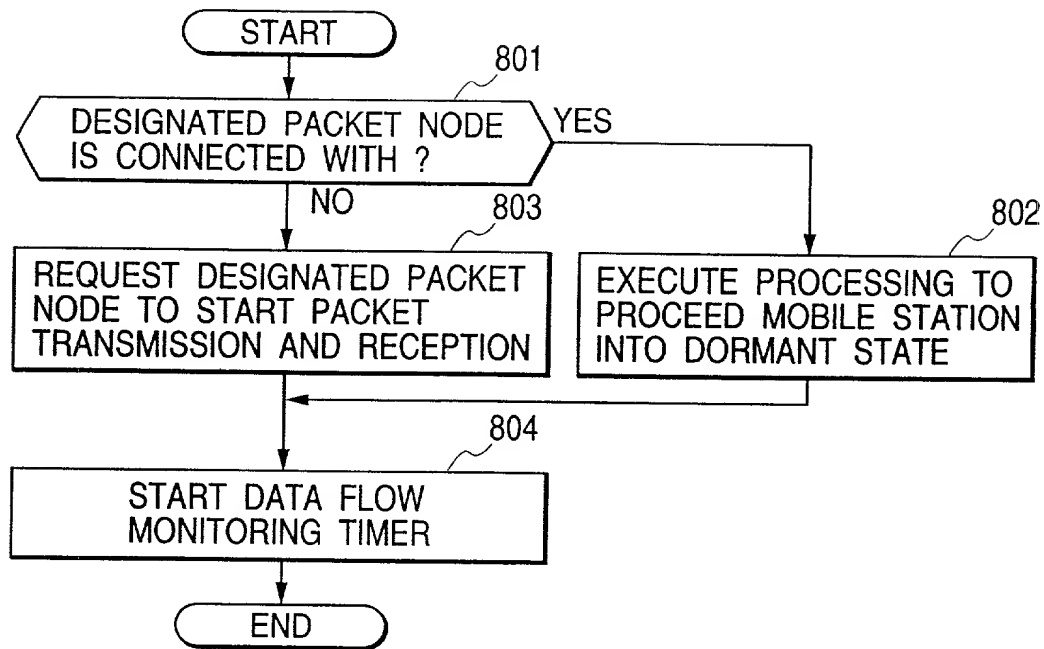
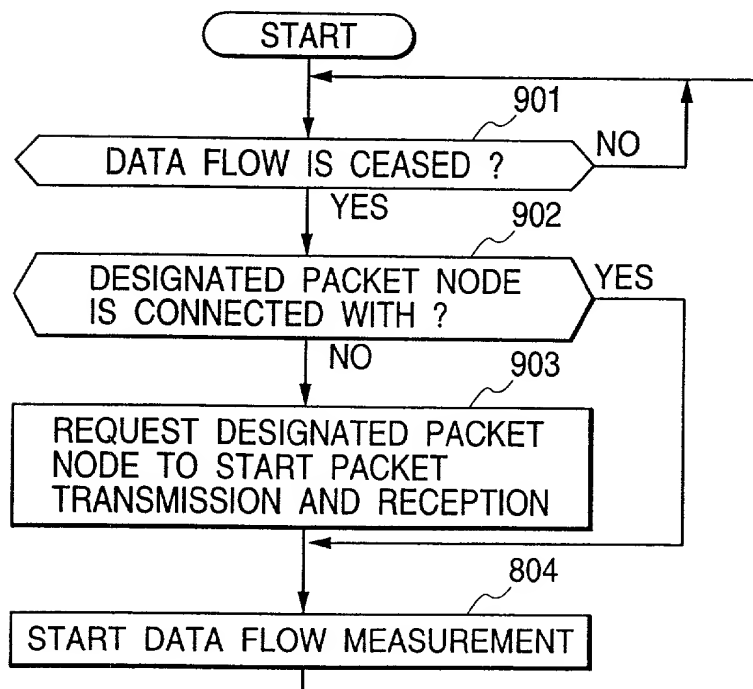


FIG. 18



Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

MOBILE IP NETWORK SYSTEM AND CONNECTION

SWITCHING METHOD

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

The specification of which is attached hereto unless the following box is checked:

☐ 月 日に提出され、米国出願番号または特許協定条約国際出願番号を _____ とし、
(該当する場合) _____ に訂正されました。

☒ was filed on 24 July, 2000
as United States Application Number or
PCT International Application Number
09/624072 and was amended on
(if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Japanese Language Declaration (日本語宣言書)

私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国以外の国の少なくとも一カ国を指定している特許協力条約365(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示している。

Prior Foreign Application(s)

外国での先行出願

11-207223
(Number)
(番号)

Japan
(Country)
(国名)

22/July/1999
(Day/Month/Year Filed)
(出願年月日)

Priority Not Claimed

優先権主張なし

☐

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願年月日)

☐

私は、第35編米国法典119条(e)項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)
(出願番号)

(Filing Date)
(出願日)

(Application No.)
(出願番号)

(Filing Date)
(出願日)

私は、下記の米国法典第35編120条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条(c)に基づき権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application No.)
(出願番号)

(Filing Date)
(出願日)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

(Application No.)
(出願番号)

(Filing Date)
(出願日)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じることに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行えば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Japanese Language Declaration (日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。(弁護士、または代理人の氏名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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